



# REPORT

ON THE

**WATER POWER,**

AT

**KINGSBRIDGE,**

*NEAR THE CITY OF NEW-YORK.*



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**REPORT**  
ON THE  
**WATER POWER,**  
AT  
**KINGSBRIDGE,**  
*NEAR THE CITY OF NEW-YORK,*  
BELONGING TO  
THE  
**NEW-YORK HYDRAULIC MANUFACTURING**  
AND  
**BRIDGE COMPANY.**

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**BY JAMES RENWICK.**

PROFESSOR OF NATURAL AND EXPERIMENTAL PHILOSOPHY AND OF  
CHEMISTRY IN COLUMBIA COLLEGE.

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.....  
1827.





TO THE  
**DIRECTORS**  
OF THE  
**New-York Hydraulic Manufacturing,**  
AND  
**BRIDGE COMPANY.**

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COLUMBIA COLLEGE, *August 30th, 1827.*

IN compliance with your request, I proceeded to Kingsbridge, on the 13th and 14th instant, and examined your property there, and also the water power, attached to that property, with a view of ascertaining the fitness of the situation for the establishment of manufactures.

The momentum, or power of water, is made up, of the quantity and of the head. Where there is great head, little quantity is required; where there is little head, greater quantity is required, to produce a given effect. My first object, therefore, was to ascertain the quantity of water; my second object, the head which that water had. In the case before us, the quantity depends on the extent of the water dammed up, by Macomb's dam, built across Hærlém-River, at the end of the Eighth Avenue: which extent was ascertained by taking the distance between that dam and Kingsbridge, from the official map of the city of New-York, and by measuring the breadth, in several places, so as to make a safe average. In establishing the breadth, a liberal allowance was made, so as to keep certainly, within the truth. The depth to which I

think expedient to draw off the water, is six inches from the surface. On these data, is founded, Estimate No. 1.

The head was ascertained by taking the level of Hærlem-River, or the pond, at the high water mark, and the level of Spuytendeuvil creek, on the west side of the mill, at Kingsbridge, at low-water mark. This was accurately done, by levelling, on the days above mentioned. On the first of those days, the difference of the two levels, was four feet and eight tenths of an inch; on the second day, four feet, three inches and nine tenths. The time was very favorable for determining the minimum difference of level, or the head, as the tides were exceedingly neap. On the first day, the Hudson, rose little more than three feet; which is a rise unusually scanty. The water of Hærlem river, too, was discharging through the open spaces for the gates; (the gates being unhung) for which reason, it did not rise within some inches of its proper height. From these facts, I am of opinion, that four feet may be considered, as the least difference of these two levels, or the least head, that, probably, will ever be experienced. On these data respecting the quantity of water, and the head, I have founded my calculations.

The water-power of Kingsbridge, in its natural state, is a tide power; and this kind of power being variable and inequable, is, therefore, unfit for manufactures requiring steady driving. To remedy this defect, it is proposed to render this power uniform and perpetual, by making use of Yonkers' river, as a reservoir, for the tail-water of such factories as may be erected, and by maintaining that river, always, at low-water mark. This river, is an inlet of the Hudson, and winds a very serpentine course of nearly three miles, through the valley, lying immediately west of Kingsbridge. For the purpose above described, a dam has been constructed across its mouth, with flood-gates, on the down stream side, so contrived as to



dam out the rising tide, thereby maintaining its surface, always at the level of low-water. We, then, have, on the one side, Hærlém-river, or the mill-pond, at all times, kept at the level of high water, and, on the other side, Yonkers' river, at all times, kept, at the level of low water: or, in other words, we may, at all times, draw our water, from a full pond, and discharge it into an empty pond. The important question, then, arises, '*By the means above described, can the water-power of Kingsbridge, be rendered uniform and perpetual.*' I answer decidedly, in the affirmative. The results, then, of my examination, are these :

That at Kingsbridge, you may offer a uniform and perpetual water-power, whose minimum head, will be four feet, and whose quantity, as will appear hereafter, is very great. (Appendix No. 1.)

That the conformation and situation of your lands, give them peculiar advantages, for manufacturing purposes; these lands being level and susceptible of easy excavation, and accessible, at all times, either by water, through the Hudson river, or, by land, over the island of New-York, without expense or interruption from a single ferry, turnpike or bridge.

The distance from the compact part, of the city of New-York is not more than twelve miles; and the water-power lies, wholly within the corporate limits of that city.

The quantity of perpetual power which may be disposed of, will depend on the capacity of Yonkers' river, considered as a reservoir, for the tail-water. This capacity is found, by ascertaining how much tail water, thrown into that river, would be necessary to raise it, from low-water mark, to such a height as would impede the water-wheels of the establishments which may be erected. In making this calculation I have not taken the length of Yonkers' river, through its various sinuosities, but have measured a section, merely, of it, as if it were

straight, and 1,200 yards, only in extent; and I have taken its smallest breadth nearly as the average width. I have considered, too, the water-wheels as placed one foot above neap low-water-mark. And the result of my calculation, is, that to discharge the requisite quantity of tail-water into Yonkers' river, would take so many factories as that their united powers, would be equal to 234 horse-powers. (See Appendix No. 2.)

I have recently had occasion to calculate the power of the mill seats, at Paterson, (note 1.) each of which I found to be equal to 23 1-3 horse-powers; and my calculation has been confirmed by the experience of one of the most intelligent manufacturers of that town. I do not hesitate, therefore, to express my opinion, that your company may fairly and safely contract, immediately, for the sale of ten mill-sites, (note 2.) of perpetual power, equal in value to those of Paterson, and may take measures accordingly; leaving the minute calculation of the full extent of their power for further consideration. In conformity with this view I have prepared a plan of a town-plot, providing for the use of the water, and for the accommodation of the manufacturers. The mill-sites are laid out 50 feet by 200; and as some species of works may require much ground I have laid out fourteen. The basis of my plan is a survey made by Stephen Ludlum, city surveyor, in 1817. I have laid out the remainder of the upland, included in that survey, in house-lots.

It being very important to preserve space, in Spuytendeuvil Creek, for a harbour, and in Yonkers' river, for tail-water, I have proposed to encroach, as little as possible on the first, and have increased, rather than diminished, the surface of the last. With this view, also, I have not proposed to join the island, at the mouth of Yonkers' river, to the main land, but to leave it separated by a canal of 20 feet in width. This will permit the current to pass through, and help to maintain a



proper depth of water, in the harbor. The island, however, will not be lost. In the event of the improvement of several of the mill-seats, it will become valuable, for stores; for which reason I have represented it as laid out in lots of 25 feet, front, of various depths. These may communicate with the main land, by bridges. To distinguish these several lots, the mill-sites are numbered in Roman, the house-lots, in Arabic numerals; and those on the island are distinguished by letters. I have not considered it necessary to extend the plan beyond the limits of Ludlum's survey, as some years will probably elapse, before it will be filled up, and as the present plan will be sufficient to occupy a considerable portion of the water. Nor would it have been necessary to go so far, at the present moment, were it not expedient that all improvement should be made, in reference to a definite plan.

The works which it will be necessary to construct, in order to bring any part of the water into use, are represented upon plan B. It will, there, be seen, that it is proposed to run a bulkhead, from the extremity of the lot formerly occupied by Perkins Nichols, to a point 110 feet, southwest of the line of the cooper's shop, making a length of 130 feet. This bulkhead will be seven feet high above low-water mark, in its whole extent. I propose to connect this bulkhead, with the shore, by another bulkhead, at right angles to the first, having two openings, one of which will be furnished with gates opening inwards, so arranged as to admit vessels. The other opening is intended for an extension of the canal as shown in plan A, but closed for the present. The total length of this bulkhead will be 110 feet, from the firm upland to its contact with the other. Both bulkheads will be 20 feet wide, built of solid stone, and made perfectly water-tight.

It will be necessary also, to excavate immediately, about 200 feet, of canal or mill-race. The position of this is mark-

ed upon the plan B, and has been located with reference to convenience of establishing mills, and cheapness of excavation. In the line which has been laid out, the excavation, will no where exceed 14 feet, the line being in its highest point, nine feet only, above high-water mark. A part of the excavation has been formerly effected, so that there will not remain more than 2,000 cubic yards to be done. A considerable portion of this will be thrown up, as an embankment, the remainder will be needed to fill up the abutments.

In addition to the works represented upon the maps as necessary to be done, I beg leave to state, that it is important, not only to its present value, but to its prospective use, that Macomb's dam across the Hærlem river be rendered tight. There appears to be little or no leakage through its base, but through the gates and piers the leakage is considerable. The piers may be easily and cheaply tightened, by planking the inner face of them. A similar precaution will be necessary on the piers of the dam across Yonkers' river.

In making up my calculations and estimates, I have taken every precaution to be far within the truth, so as to show the least power that may be had, under the most unfavourable circumstances, that no doubt may exist as to the certainty of a sufficient supply of power, for the first mill-sites, that may be occupied. The dimensions of the pond whence the water is to be drawn, will be found much greater than my estimate. The capacity of Yonkers' river, also, for the tail-water, I believe to be double what I have stated it. I have taken the most unfavourable kind of water-wheels, namely, under shot wheels: and the elevation of the tide is assumed at four feet, only, when it is a well known fact that during the increase of the moon, and the prevalence of easterly winds, the waters of the sound and, of course, of Hærlem river, will rise, seven, eight, and sometimes ten feet; which heads of water may be



retained, in the mill-pond, if Macomb's-dam be made perfectly tight. To show, in a very clear point of view, how much within the bounds of truth, are my estimates and calculations, let it be borne in mind, that instead of measuring Yonkers' river, in its whole extent, I took a small section of it only. Now, let us suppose that this river shall be found capable of receiving 20,000 cubic yards of tail-water, instead of 10,000 cubical yards, of which fact I entertain no doubt, then, the power to be disposed of, will be increased to 468 horse-powers. Again; if we substitute, in our calculations, breast wheels for under-shot wheels, that power will be farther increased to 1,000 horse-powers, or, say, 40 mill-sites, of perpetual power, equal to those of Paterson. To this extent, I am of opinion, that the effective force of the waters of Hærlem-river, belonging to the company, may be carried, by careful engineering, and by taking advantage of all the concurrent favorable circumstances.

JAMES RENWICK,

Professor of Nat. Exp. Philosophy and Chemistry in  
Columbia College.

I have read the within report of professor Renwick on the capabilities of the waters at Kingsbridge, and I have submitted the same to Colonel Totten of the corps of Engineers also, and we are of opinion that what is stated by professor Renwick, is reasonable and correct.

Given under my hand at Newport, Rhode Island, this  
twenty-fifth day of September, 1827.

ALX. MACOMB,

Maj. Gen. Chief Engineer, U. S.



## No. 1.

ESTIMATE of the quantity of water that may be furnished by drawing off six inches in depth from the surface of Hærlæm River, between Macomb's-dam, and Kingsbridge.

Length of pond	. . .	6,700 yards.
Greatest breadth	. . .	520
Least breadth for two miles	. . .	300
Assumed mean breadth	. . .	260
Surface	. . .	174,200 Sq. yards.
Afforded by drawing off six inches		29,000 Cub. yards.
Allowance for leakage	. . .	9,000
Remains for driving machinery		20,000

Twenty thousand cubical yards may, therefore be drawn each tide, or forty thousand cubical yards, in twenty-four hours.

Yonkers' river, will receive as per estimate No. 2. ten thousand cubic yards, each tide. The quantity, therefore, that can certainly be drawn from the pond, is double what is needed.

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 No. 2.

ESTIMATE of the power that may be obtained, by using the bed of Yonkers' River, to receive the tail-water of mills.

Assumed length of the river in a straight

line, much less than the truth 1,200 yards.

Greatest breadth 70 yards ; least breadth

20 yards ;

Assumed mean breadth, also less than

the truth . . . . . 25

Surface . . . . . 30,000 Sq. yards.

One foot in depth on 30,000 sq. yards is 30,000 Cub. yards.

Or . . . . . 270,000 Cub. feet.

A cubic foot of salt-water weighs

63 lbs.

17,010,000 lbs.

The least difference between high-water in the pond, and low-water, in Yonkers' river, is 4 feet.

Taking off 6 inches for the fall of the mill-pond and one foot for the rise of Yonkers' river, leaves 2 feet 6 inches head.

Water with a head of 2 feet runs with a velocity of 11 feet per second, or 660 feet per minute.

This power, therefore, is equivalent to pounds raised one foot per minute. 112,26,000,000 lbs.

But in under-shot wheels 7-10 of the whole power is lost, which reduces it to

33,67,980,000 lbs.

A horse-power, in mill-works, is equivalent to 24,000 lbs, raised one foot, per minute : and in 10 hours, to 14,400,000 lbs.

The quantity of tail-water, therefore, which Yonkers' Creek, is capable of receiving is equal to

Horse-powers 234

Equivalent to 10 mill-sites of perpetual power at Paterson.

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Note 1.

The term, *Horse-power*, used as the conventional measure of the force of different mechanical agents, is of no certain determinate value, being from its nature, vague and variable. Still however, the manner, in which it is used, by standard writer, or mechanics, and understood, by practical machinists, will

serve as a guide, in its application. Smeaton assumes a horse-power to be capable of raising 22,000 lbs. one foot high, per minute. Desagiullers makes the weight as much as 275,000 lbs. and the sum 24,000 has been frequently used in the calculation of the power of water-wheels. In the estimates of the best manufacturers of steam-engines, in this city, the measure of a horse power, is extended as far as 32,000 lbs. and even 33,000 lbs. But it is to be observed, by the estimate of Watt, that in a steam engine, one fourth part of the power, is lost between the point, where the reciprocating motion of the piston is induced, and that on the circumference described by the crank when the circular motion is ready to be applied to work machinery. In a water-wheel, on the other hand, when applied to produce rotary motion, no such loss of power occurs. Thus, therefore, a water-wheel actuated, by a power capable of raising 24,000 lbs. one foot high per minute, will drive as much rotary machinery, as a steam-engine, whose power, estimated upon the piston, is equivalent to 32,000 lbs. raised to the same height, in the same space of time.

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Note 2.

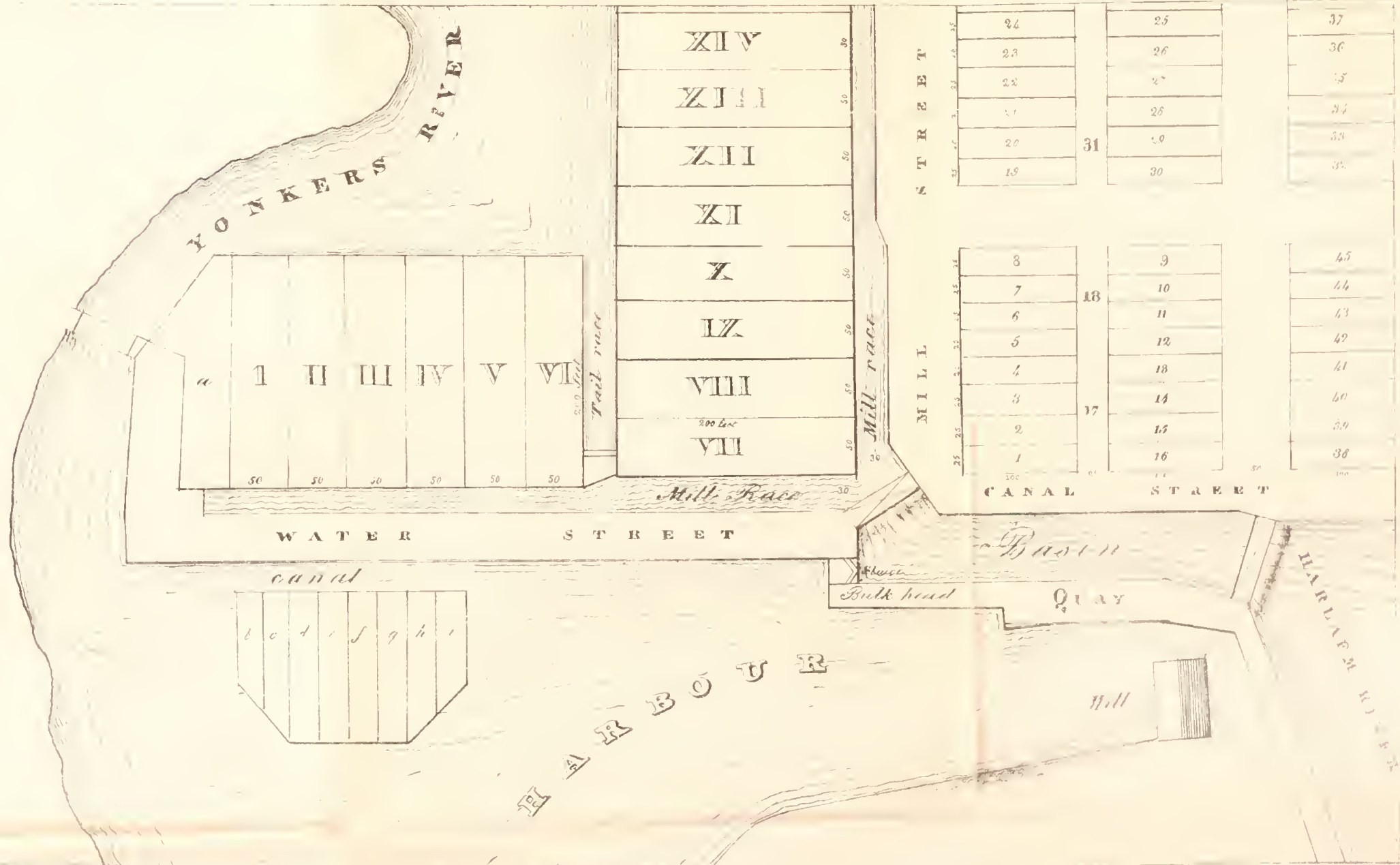
It will be admitted that the town of Paterson, N. J. owes its prosperity, to the employment of its water-power. There are, now, in operation, at that place, 16 manufacturing establishments: and these give support, directly and indirectly to a population of 6,200.



# PLAN A.

PLAN of the Manufacturing Village of **KINGSBRIDGE** belonging to the New York Hydraulic COMPANY

Mill Sites are distinguished by Roman, Building Lots by Arabic Numerals.



Projected from Surveys made by Wm. Mangin & Luddlow by Jas. Renwick



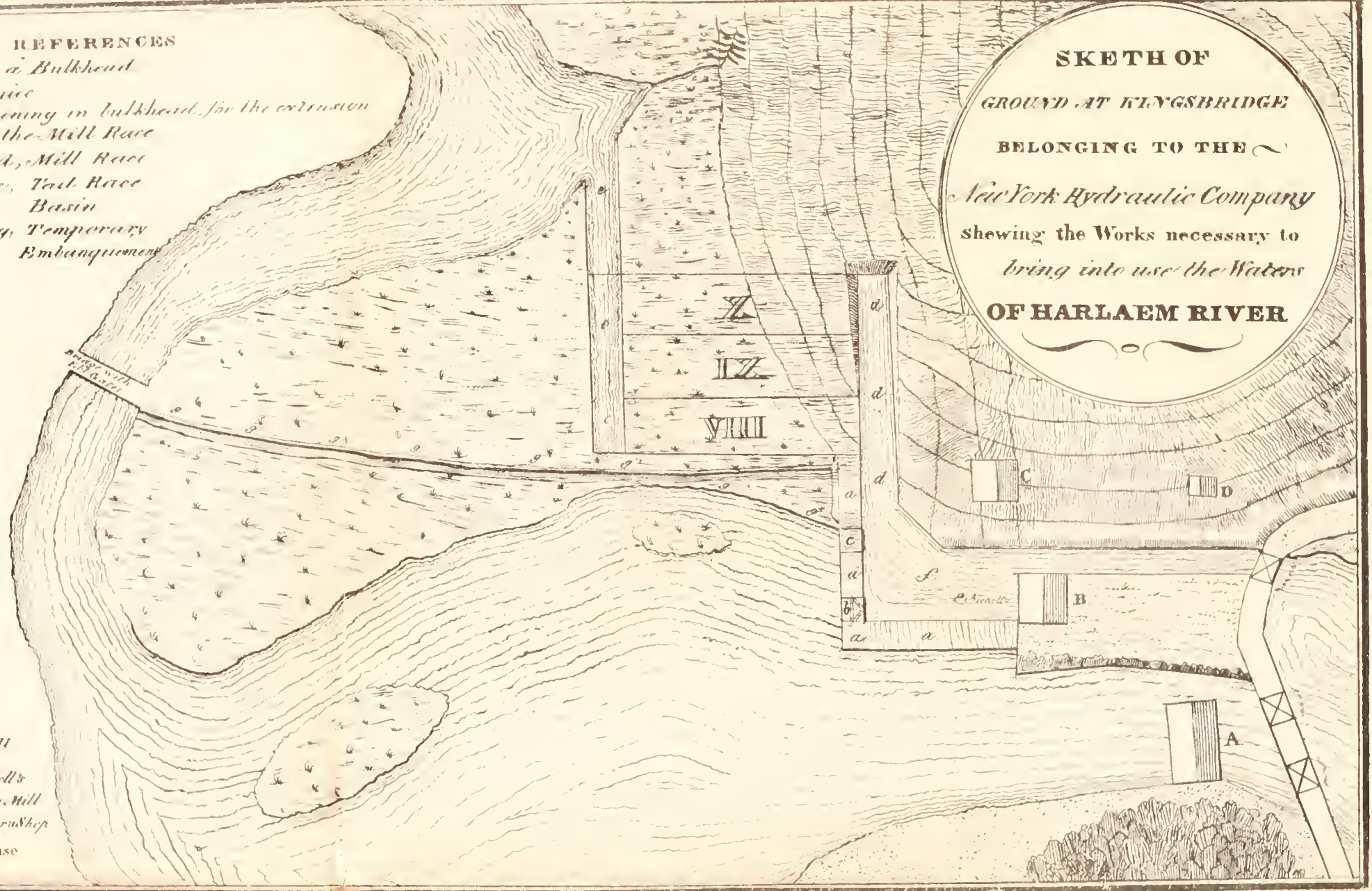
# PLAN B.

## REFERENCES

- a, a, a* Bulkhead
- b* Sluice
- c* Opening in bulkhead, for the extension of the Mill Race
- d, d, d* Mill Race
- e, e, e* Tail Race
- f* Basin
- g, g, g* Temporary Embankment

SKETCH OF  
GROUND AT KINGSBRIDGE  
BELONGING TO THE  
*New York Hydraulic Company*  
shewing the Works necessary to  
bring into use the Waters  
OF HARLAEM RIVER

- A Mill
- B. Nichol's  
Marble Mill
- C Cooper's Shop
- D House







HUDSON

RIVER

Rebaults

Et Washouten

Et Tamm

NEW YORK

ISLAND

WESTCHESTER Co

Yonkers River

Kingsbridge

Grant of H. IRLAEM

RIVER

Marble Quarry

Macomb

Robert

WESTCHESTER COUNTY

Hudson River at



Harlem River Level of High Water at Neap Tides

Yonkers River Level of low Water at Neap Tides





EVERY  
CLASS

